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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

REQUEST FORM FOR FILING CONTINUING APPLICATION UNDER 37 C.F.R. § 1.53(b)

Attorney Docket Number 13DV-13434
Anticipated Classification Of This Application:
Class _________ Subclass ____________

Prior Application: 08/577,071
Examiner:
Art Unit:

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

This is a request for filing a [ ] continuation [x] **divisional application** under 37 C.F.R. § 1.53(b) of prior application, Application Serial No. **08/577,071**, filed on **December 22, 1995**, entitled **NICKEL-BASE SUPERALLOY HAVING AN OPTIMIZED PLATINUM-ALUMINIDE COATING** by the following named inventor **Jon C. SCHAEFFER**.

1. [X] Enclosed is a true copy of the prior complete application as originally filed, including the oath or declaration. No amendments referred to in the oath or declaration filed to complete the prior application introduced new matter therein.
2. [X] Preliminary Amendment is enclosed.
3. [ ] Cancel in this application original claims _______ of the prior application before calculating the filing fee. At least one original independent claim is retained to complete the prior application introduced new matter therein.
4. [X] The filing fee is calculated as follows:

FOR	NUMBER FILED	NUMBER EXTRA	RATE		CALCULATIONS
TOTAL CLAIMS	111	91	x $ 18.00 =		$1,638.00
INDEPENDENT CLAIMS	15	12	x $ 78.00 =		936.00
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			x $ 130.00		$ 0.00
			BASIC FEE	+	$ 690.00
			TOTAL OF ABOVE CALCULATIONS=	+	$ 3,264.00
REDUCTION BY ½ FOR FILING BY SMALL ENTITY (Note 37 C.F.R. 1.9, 1.27, 1.28). IF APPLICABLE, VERIFIED STATEMENT MUST BE ATTACHED.				-	$
			TOTAL =		$ 3,264.00

5. [X] The Commissioner is hereby authorized to charge fees under 37 C.F.R. § 1.16 and § 1.17 which may be required, or credit any overpayment to Deposit Account No. 07-0865, account holder: General Electric Company, H17 Cincinnati, Ohio 45215-6301.
6. [X] A check in the amount of $ 3,264.00 is enclosed. In the event any variance exists between the amount enclosed and the Patent Office charges, please credit or charge any different to Deposit Account No. 50-0206.
7. [X] Amend the specification by inserting before the first line the sentence:
   This is a divisional of U.S. Application, Serial Number 08/577,071, filed December 22, 1995.
8. [ ] A verified statement to establish small entity status under 37 C.F.R. § § 1.9 and 1.27

   [ ] is enclosed.

   [ ] was filed in prior application Serial No. _____________ and such status is still proper and desired (37 C.F.R. § 1.28(a)).

9. [ ] Priority of foreign Application Nos. ________, filed on _______, is claimed under 35 U.S.C. § 119.

[ ] A certified copy of each was filed in prior Application Serial No. ____, filed _____.

10. [ ] New formal drawings are enclosed.

11. [X] The prior application is assigned of record to General Electric Company

12. [X] The power of attorney

a. [X] The power of attorney appears in the original papers in the prior application.
b. [ ] Since the power does not appear in the original papers, a copy of the power in the prior application is enclosed.

13. [x] Enclosed are Associate Powers of attorney to the Undersigned Counsel.

14. [ ] Also enclosed: An INFORMATION DISCLOSURE STATEMENT. Attached is a Form PTO-1449 listing all of the documents cited by Applicant and the PTO in the parent application Serial No. 09/089,214 relied upon 35 U.S.C. § 120. Per Rule 98(d), copies of the listed documents are not required now. Please consider these documents and advise that they have been considered in this new application by returning a copy of the enclosed Form PTO-1449 with the Examiner's initials in the left column per M.P.E.P. 609.

15. [X] Address all future communications to:

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CUSTOMER NUMBER: 00611

The undersigned further declares that all statements made herein of his own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that willful false statements may jeopardize the validity of the applications or any patent issuing thereon.

Dated: January 4, 2000

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Attorney Docket No. 13DV-13434 Divisional of 13DV12273

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	)	APPLICATION BRANCH
Jon C. SCHAEFFER	)	Examiner: Not Assigned
Serial No.: To Be Assigned	)	Group Art Unit: Not Assigned
Filing Date: January 4, 2000	)	
Prior Application: Serial No. 08/577,071 Filed: December 22, 1995	)	Examiner: LaVilla Group Art Unit: 1316

Title: NICKEL-BASE SUPERALLOY HAVING AN OPTIMIZED PLATINUM-ALUMINIDE COATING

PRELIMINARY AMENDMENT

Honorable Commissioner of
Patents and Trademarks
Washington, DC 20231

Sir:

Prior to the examination of the above-identified patent application, please amend the application as follows:

IN THE CLAIMS

Please add new claims 21-111 set forth below.

--21. An article for use in a gas turbine engine, comprising:

a nickel based superalloy substrate,

a chemical vapor deposited, diffusion aluminide layer formed on the substrate,

said aluminide layer having an outer layer region comprising a solid solution intermediate phase and having an inner diffusion zone region proximate the substrate,

said intermediate phase includes an average aluminum concentration in the range of about 18 to about 28% by weight, an average platinum concentration in the range of about 8 to about 45% by weight, and an average nickel concentration in the range of about 50 to about 60% by weight

so as to be non-stoichiometric relative to intermetallic compounds of aluminum and nickel, or aluminum and platinum, said outer layer region being substantially free of phase constituents other than said intermediate phase,

an alumina layer on the aluminide layer, and

a ceramic thermal barrier layer on the alumina layer.

22. The article of claim 21, wherein said intermediate phase resides in a beta solid solution intermediate phase region of a binary nickel-aluminum phase diagram.

23. The article of claim 21 wherein said outer layer region is about 1.5 to about 4.0 mils in thickness.

24. The article of claim 21 wherein said ceramic thermal barrier layer comprises a columnar microstructure.

25. The article of claim 21 wherein the ceramic thermal barrier layer comprises yttria stabilized zirconia.

26. An article for use in a gas turbine engine, comprising:

a nickel base superalloy substrate,

a chemical vapor deposited, diffusion aluminide layer formed on the substrate,

said aluminide layer having an outer layer region comprising a nickel-aluminum solid solution intermediate beta phase and an inner diffusion zone region proximate the substrate,

said intermediate phase including an average aluminum concentration in the range of about 18 to about 28% by weight, an average platinum concentration in the range of about 8 to about 45% by weight, and an average nickel concentration of about 50 to about 60% by weight so as to be non-stoichiometric relative to intermetallic compounds of aluminum and nickel and of aluminum and platinum, said outer layer region being free of phase constituents other than said intermediate beta phase,

a thermally grown alpha alumina layer on the aluminide layer, and

a ceramic thermal barrier layer vapor deposited on the alumina layer to have a columnar microstructure.

27. The article of claim 26 wherein said outer layer region is about 1.5 to about 4.0 mils in thickness.

28. The article of claim 26 wherein the ceramic thermal barrier layer comprises yttria stabilized zirconia.

29. A method of forming a thermal barrier coating on a substrate, comprising:

chemical vapor depositing a diffusion aluminide layer on the substrate which includes a nickel based superalloy substrate

under deposition conditions effective to provide an outer aluminide layer region comprising a solid solution intermediate phase and an inner diffusion zone region proximate the substrate,

said intermediate phase including an average aluminum concentration in the range of about 18 to about 28% by weight, an average platinum concentration in the range of about 8 to about 45% by weight, and an average nickel concentration of about 50 to about 60% by weight

so as to be non-stoichimetric relative to intermetallic compounds of aluminum and nickel, or aluminum and platinum, said outer layer region being substantially free of phase constituents other than said intermediate phase,

oxidizing the aluminide layer under temperature and oxygen partial pressure conditions effective to form an alpha alumina layer, and

depositing a ceramic thermal barrier layer on the alumina layer.

30. The method of claim 29 wherein said intermediate phase resides in a beta solid solution intermediate phase region of a binary nickel-aluminum phase diagram.

31. The method of claim 29 wherein said outer layer region is formed to a thickness of about 1.5 to about 4.0 mils.

32. The method of claim 29 wherein said ceramic thermal barrier layer is deposited by vapor condensation on said substrate so as to have a columnar microstructure.

33. The article of claim 21, wherein said intermediate phase comprises an average aluminum concentration of about 18 to about 27% by weight.

34. The article of claim 21, wherein said intermediate phase comprises an average aluminum concentration of about 18 to about 27% by weight, and an average platinum concentration of about 18 to about 45% by weight.

35. The article of claim 21, wherein said intermediate phase comprises an average aluminum concentration of about 21 to about 26% by weight and an average platinum concentration of about 30 to about 45% by weight.

36. The article of claim 21 wherein said outer layer region is about 2.5 mils in thickness.

37. The article of claim 21, wherein said intermediate phase comprises a surface, distant from said inner diffusion zone region, and the intermediate phase includes an average aluminum concentration and an average platinum concentration which is relatively high adjacent to the surface and decreases with increasing depth into the intermediate phase.

38. The article of claim 21, wherein said ceramic thermal barrier layer is deposited by electron beam physical vapor deposition.

39. The article of claim 26 wherein said intermediate phase comprises an average aluminum concentration of about 18 to about 27% by weight, and an average platinum concentration of about 18 to about 45% by weight.

40. The article of claim 26 wherein said intermediate phase comprises an average aluminum concentration of about 21 to about 26% by weight and an average platinum concentration of about 30 to about 45% by weight.

41. The article of claim 26 wherein said outer layer region is about 2.5 mils in thickness.

42. The article of claim 26 wherein said intermediate phase comprises a surface, distant from said inner diffusion zone region, and the intermediate phase includes the aluminum content and the platinum content which is relatively high

35. The article of claim 21, wherein said intermediate phase comprises an average aluminum concentration of about 21 to about 26% by weight and an average platinum concentration of about 30 to about 45% by weight.

36. The article of claim 21 wherein said outer layer region is about 2.5 mils in thickness.

37. The article of claim 21, wherein said intermediate phase comprises a surface, distant from said inner diffusion zone region, and the intermediate phase includes an average aluminum concentration and an average platinum concentration which is relatively high adjacent to the surface and decreases with increasing depth into the intermediate phase.

38. The article of claim 21, wherein said ceramic thermal barrier layer is deposited by electron beam physical vapor deposition.

39. The article of claim 26 wherein said intermediate phase comprises an average aluminum concentration of about 18 to about 27% by weight, and an average platinum concentration of about 18 to about 45% by weight.

40. The article of claim 26 wherein said intermediate phase comprises an average aluminum concentration of about 21 to about 26% by weight and an average platinum concentration of about 30 to about 45% by weight.

41. The article of claim 26 wherein said outer layer region is about 2.5 mils in thickness.

42. The article of claim 26 wherein said intermediate phase comprises a surface, distant from said inner diffusion zone region, and the intermediate phase includes the aluminum content and the platinum content which is relatively high

adjacent to the surface and decreases with increasing depth into the intermediate phase.

43. The article of claim 26, wherein said ceramic thermal barrier layer is deposited by electron beam physical vapor deposition.

44. The method of claim 29 wherein said intermediate phase comprises an average aluminum concentration of about 18 to about 27% by weight and, an average platinum concentration of about 18 to about 45% by weight.

45. The method of claim 29 wherein said intermediate phase comprises average aluminum content of about 21 to about 26% by weight and average platinum content of about 30 to about 45% by weight.

46. The method of claim 29 wherein said outer layer region is about 2.5 mils in thickness.

47. The method of claim 29 wherein said intermediate phase comprises a surface, distant from said inner diffusion zone region, and the intermediate phase includes the aluminum content and the platinum content which is relatively high adjacent to the surface and decreases with increasing depth into the intermediate phase.

48. The method of claim 29 wherein said ceramic thermal barrier layer is deposited by electron beam physical vapor deposition.

49. An article for use in a gas turbine engine, comprising:

a nickel based superalloy substrate,

a chemical vapor deposited, diffusion aluminide layer formed on the substrate,

said diffusion aluminide layer including an average aluminum concentration in the range of about 18 to about 28% by weight, an average platinum concentration in the range of about 8 to about 45% by weight, and

a ceramic thermal barrier layer on the aluminide layer.

50. The article of claim 49 wherein said outer layer region is about 1.5 to about 4.0 mils in thickness.

51. The article of claim 49 wherein the ceramic thermal barrier layer comprises yttria stabilized zirconia.

52. An article for use in a gas turbine engine, comprising:

a nickel base superalloy substrate,

a chemical vapor deposited, diffusion aluminide layer formed on the substrate,

said diffusion aluminide layer including an average aluminum concentration in the range of about 18 to about 28% by weight, an average platinum concentration in the range of about 8 to about 45% by weight, and

a ceramic thermal barrier layer vapor deposited on the aluminide layer.

53. The article of claim 52 wherein said diffusion aluminide layer includes an average platinum concentration of about 18 to about 45% by weight.

54. The article of claim 52 wherein said diffusion aluminide layer is about 1.5 to 4.0 mils in thickness.

55. The article of claim 52 wherein the ceramic thermal barrier layer comprises yttria stabilized zirconia.

56. A method of forming a thermal barrier coating on a substrate, comprising:

chemical vapor depositing a diffusion aluminide layer on the substrate which includes a nickel based superalloy substrate,

said aluminide layer including an average aluminum concentration in the range of about 18 to about 28% by weight, an average platinum concentration in the range of about 8 to about 45% by weight, and

depositing a ceramic thermal barrier layer on the aluminide layer.

57. The method of claim 56 wherein said aluminide layer includes an average platinum concentration in the range of about 18 to about 45% by weight.

58. The method of claim 56 wherein said aluminide layer is formed to a thickness of about 1.5 to about 4.0 mils.

59. The method of claim 56 wherein said ceramic thermal barrier layer is deposited by vapor condensation on said substrate so as to have a columnar microstructure.

60. The article of claim 49, wherein said diffusion aluminide layer comprises an average aluminum concentration of about 18 to about 27% by weight, and an average platinum concentration of about 18 to about 45% by weight.

61. The article of claim 49, wherein said diffusion aluminide layer comprises average aluminum content of about 21 to about 26% by weight and average platinum content of about 30 to about 45% by weight.

62. The article of claim 49 wherein said outer layer region is about 2.5 mils in thickness.

63. The article of claim 49, wherein said diffusion aluminide layer comprises a surface, and the aluminum content and the platinum content is relatively high adjacent

to the surface and decreases with increasing depth into the diffusion aluminide layer and the substrate.

64. The article of claim 49, wherein said ceramic thermal barrier layer is deposited by electron beam physical vapor deposition.

65. The article of claim 52 wherein said diffusion aluminide layer comprises an average aluminum concentration of about 18 to about 24% by weight, and an average platinum concentration of about 18 to about 45% by weight.

66. The article of claim 52 wherein said diffusion aluminide layer comprises an average aluminum content of about 21 to about 26% by weight and an average platinum content of about 30 to about 45% by weight.

67. The article of claim 52 wherein the diffusion aluminide layer is about 2.5 mils in thickness.

68. The article of claim 52 wherein said diffusion aluminide layer comprises a surface, and the aluminum content and the platinum content is relatively high adjacent to the surface and decreases with increasing depth into the diffusion aluminide layer and the substrate.

69. The article of claim 52, wherein said ceramic thermal barrier layer is deposited by electron beam physical vapor deposition.

70. The method of claim 56 wherein said diffusion aluminide layer comprises an average aluminum concentration of about 18 to about 27% by weight, and an average platinum concentration of about 18 to about 45% by weight.

71. The method of claim 56 wherein said diffusion aluminide layer comprises average aluminum content of about 21 to about 26% by weight and average platinum content of about 30 to about 45% by weight.

72. The method of claim 56 wherein said diffusion aluminide layer is about 2.5 mils in thickness.

73. The method of claim 56 wherein said diffusion aluminide layer comprises a surface, and includes the aluminum content and the platinum content which is relatively high adjacent to the surface and decreases with increasing depth into the diffusion aluminide layer and the substrate.

74. The method of claim 56 wherein said ceramic thermal barrier layer is deposited by electron beam physical vapor deposition.

75. An article comprising:

a nickel-base superalloy substrate including a substrate surface;

a single phase platinum-aluminide surface region proximate to the substrate surface, said article exhibiting an environmental life expressed in hours of exposure per 1 mil of the surface region of more than about 2 relative lives under high-velocity, 0.5 ppm salt environment at 2150°F.

76. The article of claim 75, wherein said aluminide surface region comprises from about 18 to about 28% by weight integrated aluminum content, from about 6 to about 45% by weight integrated platinum content and from about 25 to about 76% by weight integrated nickel content.

77. The article of claim 75 wherein said platinum-aluminide surface region has a thickness of from about 0.0015 to about 0.004 inches.

78. The article of claim 75, wherein said platinum-aluminide surface region comprises from about 20 to about 27% by weight integrated aluminum content and from about 18 to about 45% by weight integrated platinum content.

79. The article of claim 75, wherein said platinum-aluminide surface region comprises about 25 to about 62% by weight integrated nickel content.

80. The article of claim 75, wherein said platinum-aluminide surface region comprises about 21 to about 26% by weight integrated aluminum content and about 30 to about 45% by weight of integrated platinum content.

81. The article of claim 75, wherein said platinum-aluminide surface region comprises from about 21 to about 26% by weight integrated aluminum content and about 30 to about 34% by weight integrated platinum content.

82. The article of claim 75, wherein said platinum-aluminide region comprises from about 26 to about 49% by weight integrated nickel content.

83. The article of claim 75, wherein said platinum-aluminide region comprises from about 37 to about 49% by weight integrated nickel content.

84. The article of claim 75 further comprising a ceramic layer adjacent said substrate surface.

85. The article of claim 84 wherein the ceramic layer comprises yttria-stabilized zirconia.

86. The article of claim 75 wherein said platinum-aluminide surface region extends from the substrate surface into the substrate to a distance where the aluminum content is less than about 18% by weight.

87. The article of claim 75 wherein said nickel-base superalloy substrate is substantially a single crystal in form.

88. The article of claim 75 wherein said nickel-base superalloy substrate is RN5 or RN6.

89. A method of forming a platinum-aluminide surface region proximate to the surface of a nickel-base superalloy substrate, comprising:

forming a platinum layer at the substrate surface by a method selected from the group consisting of electroplating, sputtering and metallo-organic chemical vapor deposition;

heating the substrate to a temperature of from about 1800 to about 2000°F for a time of about 2 hours;

depositing aluminum onto the nickel-base superalloy substrate by using an aluminum source and diffusing said aluminum into the substrate surface at an elevated temperature, at an aluminum activity of from about 40 to about 50 atomic percent in a pure nickel foil, and for a time of from about 4 to about 16 hours to form a substantially single phase platinum-aluminide surface region proximate the substrate surface, said platinum-aluminide surface region comprising from about 18% to about 28% by weight integrated aluminum content, from about 8 to about 45% by weight integrated platinum content and from about 31% by weight to about 74% by weight integrated nickel content.

90. The method of claim 89 wherein the heating of the substrate diffuses the platinum into the substrate.

91. The method of claim 89 wherein the aluminum is deposited at a temperature of about 1925 to about 2050°F.

92. The method of claim 89 further comprising the steps of annealing the platinum-aluminide surface region at a temperature of from about 1800 to about 2000°F for a time of from about 0.25 to about 2 hours.

93. The method of claim 92 further comprising the step of depositing a ceramic on the substrate surface.

94. The method of claim 93 wherein said ceramic includes yttria-stabilized zirconia.

95. An article comprising a single phase platinum-aluminide surface region proximate the surface of a nickel base superalloy substrate made by the method of claim 90.

96. An article comprising: a substrate which includes a nickel base superalloy;

a diffusion aluminide layer comprising a substantially single phase, said single phase comprising an average aluminum concentration in the range of from about 18 to about 28% by weight, an average platinum concentration in the range of from about 8 to about 45% by weight, and an average nickel concentration in the range of from about 21 to about 74% by weight.

97. The article of claim 96 wherein said diffusion aluminide layer phase extends from the substrate surface into the substrate to a distance where the aluminum content is about 18% by weight or less.

98. The article of claim 96 wherein said nickel superalloy substrate is substantially a single crystal in form.

99. The article of claim 96 wherein said nickel superalloy substrate is RN5 or RN6.

100. An article having a platinum-aluminide surface region, comprising:

a substrate having a nickel-base superalloy substrate bulk composition and a substrate surface; and

a surface region at the substrate surface and extending from the substrate surface into the substrate to a distance defined by an upper limit of integration that is the distance where a weight percent of aluminum has decreased to 18% from a higher value closer to the surface, the surface region having an integrated aluminum content of from about 18 to about 28% by weight and an integrated platinum content of from about 18 to about 45% by weight, balance components of the substrate bulk composition, wherein the sum of the integrated aluminum content, the integrated platinum content, and the components of the substrate bulk composition in the surface region total 100% by weight.

101. The article of claim 1, wherein the integrated aluminum content of the surface region is from about 21 to about 23% by weight and the integrated platinum content of the surface region is from about 30 to about 45% by weight.

102. The article of claim 1, further including a ceramic layer overlying the surface region.

103. The article of claim 3, wherein the ceramic layer has a thickness of from about 0.005 to about 0.015 inches.

104. The article of claim 1, wherein the thickness of the surface region is from about 0.0015 to about 0.0004 inches.

105. The article of claim 1, wherein the substrate is selected from the group consisting of a turbine blade and a turbine vane.

106. The article of claim 1, wherein the nickel-base superalloy substrate is substantially a single crystal and the substrate bulk composition includes from about 6 to about 41 weight percent aluminum and from about 1 to about 8 weight percent rhenium.

107. The article of claim 1, where the nickel-base superalloy substrate is substantially a single crystal and the substrate bulk composition is selected from the group having a composition, in weight percent, consisting of (a) 7.5% cobalt, 7% chromium, 6.2% aluminum, 6.5% tantalum, 5% tungsten, 1.5% molybdenum, 3% rhenium, balance nickel; (b) 12.5% cobalt, 4.5% chromium, 6% aluminum, 7.5% tantalum, 5.8% tungsten, 1.1% molybdenum, 5.4% rhenium, 0.15% hafnium, balance nickel; and (c) 12% cobalt, 6.8% chromium, 6.2% aluminum, 6.4% tantalum, 4.9% tungsten, 1.5% molybdenum, 2.8% rhenium, 1.5% hafnium, balance nickel.

108. An article prepared by the method comprising the steps of:

providing a substrate having a nickel-base alloy substrate bulk composition and a substrate surface;

depositing a layer of platinum upon the substrate surface;

diffusing platinum from the layer of platinum into the substrate surface;

providing a source of aluminum; and

diffusing aluminum from the source of aluminum into the substrate surface for a time sufficient to produce a surface region at the substrate surface and extending from the substrate surface to a distance defined by an upper limit of integration that

is the distance where the weight percent of aluminum has decreased to 18% from a higher value closer to the surface, the surface region having an integrated aluminum content of from about 18 to about 28% by weight and an integrated platinum content of from about 18 to about 45% by weight, balance components of the substrate bulk composition.

109. The article of claim 15, further including a ceramic layer overlying the surface region.

110. An article prepared by a method comprising the steps of

providing a substrate having a nickel-base superalloy substance bulk composition and a substrate surface; thereafter

depositing a layer of platinum about 0.0003 inches thick upon the substrate surface; thereafter

heating the substrate and layer of platinum to a temperature of about 1800-2000°F for a time of about 2 hours; thereafter

providing a source of aluminum in contact with the substrate surface, the source of aluminum having an activity of about 40 to about 50 atomic percent as measured in a pure nickel foil; and simultaneously

heating the substrate surface and source of aluminum to a temperature of about 1925-2050°F for a time of from about 4 to about 16 hours.

111. The article of claim 20, wherein the method of preparing the article includes an additional step, after the step of heating the substrate surface and source of aluminum, of

depositing a ceramic layer overlying the substrate surface.--

REMARKS

I. Statement Under 37 C.F.R § 1.607(c)

Pursuant to 37 C.F.R. § 1.607(c), Applicant wishes to advise that at least some claims of this Amendment correspond exactly or substantially to claims of Murphy, U.S. Patent 5,856,027. At least Applicant's claims 21-32 and 49-59 correspond to claims of Murphy as set forth below:

Claims of Schaeffer	Claims of Murphy
21	1
22	2
23	4
24	5
25	7
26	9
27	10
28	11
29	12
30	13
31	15
32	17
49	1
50	4
51	7
52	9
53	9
54	10
55	11
56	12
57	12
58	15
59	17

Support for all claims introduced in this Amendment is found in the specification, considered as a whole, exemplified as follows:

Claim	Support
21, 26, 49, 52, 53, 56, 57, 76	Pages 4-9, e.g., page 8, lines 26-28 and page 4, lines 21-22; Fig. 4
22, 30	Disclosed processes, compositions and Fig. 4
23, 27, 31, 54, 58, 104	Page 5, lines 15-17
24, 93	Page 9, lines 13-15
25, 28, 51, 55, 59	Page 9, lines 13-19
42, 47	Page 7, line 30-page 8, line 1
29, 56, 89-91	Pages 3; 5-9; Fig. 4
32, 43, 48, 84, 85, 102, 103	Page 9, lines 13-19
34, 39, 44, 60, 65, 70, 77	Page 3, lines 6-9; Fig. 4
34, 35, 40, 45, 61, 66, 71	Page 3, lines 6-11; Fig. 4
36, 41, 62, 67, 72	Page 9, lines 4-5
37, 63, 68, 73	Page 7, line 30-page 8, line 1
38, 64, 69, 74, 94	Page 9, lines 15-19
46, 95	Page 9, lines 3-5; pages 5-9
75	Pages 9-10, Fig. 4
76, 78-83	Pages 9-10 and Fig. 4
86	Page 8, lines 18-21
87	Page 5, line 20-page 6, line 30
88	Page 5, line 30-page 6, line 4
92	Page 9, lines 7-12
96	Page 5, lines 4-6 and 20; pages 9-10, Fig.4

Claim	Support
97	Page 8, lines 19-21
98	Page 5, line 21
99	Pages 5-7
100	Pages 8-9; Fig. 4
101	Pages 9-10
100-111	Claims 1-20

II. Request for Allowance

An indication of allowance of all claims is solicited.

In the event any variance exists between the fees submitted and the Patent Office charges, the Assistant Commissioner is authorized to credit or charge Deposit Account No. 07-0865.

Respectfully Submitted,

Hunton & Williams

Date: January 4, 2000

By: Stanislaus Aksman
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NICKEL-BASE SUPERALLOY HAVING AN OPTIMIZED PLATINUM-ALUMINIDE COATING

BACKGROUND OF THE INVENTION

This invention relates to nickel-base superalloys used in high-temperature applications, and, more particularly, to articles made of such materials and having an optimized platinum-aluminide protective coating.

In an aircraft gas turbine (jet) engine, air is drawn into the front of the engine, compressed by a shaft-mounted compressor, and mixed with fuel. The mixture is combusted, and the resulting hot exhaust gases are passed through a turbine mounted on the same shaft. The flow of gas turns the turbine, which turns the shaft and provides power to the compressor. The hot exhaust gases flow from the back of the engine, driving it and the aircraft forwardly.

The hotter the exhaust gases, the more efficient is the operation of the jet engine. There is thus an incentive to raise the exhaust gas temperature. However, the maximum temperature of the exhaust gases is normally limited by the materials used to fabricate the turbine vanes and turbine blades of the turbine. In current engines, the turbine vanes and blades are made of nickel-based superalloys and can operate at temperatures of up to 1900-2100°F.

Many approaches have been used to increase the operating temperature limit of the turbine blades and vanes. The compositions and processing of the materials themselves have been improved. Physical cooling techniques are used. In one widely used approach, internal cooling channels are provided within the components, and cool air is forced through the channels during engine operation.

In another approach, a metallic protective coating or a ceramic/metal thermal barrier coating system is applied to the turbine blade or turbine vane component, which acts as a substrate. The metallic protective coating is useful in intermediate-temperature applications. One known type of metallic protective coating is a

platinum-aluminide coating that is formed by depositing platinum and aluminum onto the surface of the substrate and then diffusing these constituents into the surface of the substrate.

The thermal barrier coating system is useful in high-temperature applications. The thermal barrier coating system includes a ceramic thermal barrier coating that insulates the component from the hot exhaust gas, permitting the exhaust gas to be hotter than would otherwise be possible with the particular material and fabrication process of the component. Ceramic thermal barrier coatings usually do not adhere well directly to the superalloys used in the substrates. Therefore, an additional metallic layer called a bond coat is placed between the substrate and the thermal barrier coating. The bond coat is usually made of a nickel-containing overlay alloy, such as a NiCrAlY or a NiCoCrAlY, of a composition more resistant to environmental damage than the substrate. The bond coat may also be made of a diffusional nickel aluminide or platinum aluminide, whose surface oxidizes to a protective aluminum oxide scale.

While superalloys coated with such metallic protective coatings or ceramic/metal thermal barrier coating systems do provide substantially improved performance over uncoated materials, there remains room for improvement in elevated temperature performance and environmental resistance. There is an ongoing need for improved metallic protective coatings and bond coats to protect nickel-base superalloys in elevated-temperature applications. This need has become more acute with the development of the newest generation of nickel-base superalloys, inasmuch as the older protective coatings are often not satisfactory with these materials. The present invention fulfills this need, and further provides related advantages.

SUMMARY OF THE INVENTION

The present invention provides a metallic overcoating for nickel-base superalloys. The overcoating is a platinum-aluminide useful as a metallic protective coating or as a bond coat for the thermal barrier coating system. The overcoating is in the form of a surface region that is well bonded to the substrate. The platinum-

aluminide coating has good elevated-temperature stability and resistance to environmental degradation in typical gas-turbine engine applications.

In accordance with the invention, an article having a platinum-aluminide surface region comprises a substrate having a nickel-base alloy substrate bulk composition and a substrate surface, and a surface region at the substrate surface. The surface region has an integrated aluminum content of from about 18 to about 24 percent by weight and an integrated platinum content of from about 18 to about 45 percent by weight, balance components of the substrate bulk composition totalling 100 weight percent. Preferably, the surface region has an integrated aluminum content of from about 21 to about 23 percent by weight and an integrated platinum content of from about 30 to about 45 percent by weight. All compositions stated herein for surface regions are determined by an integration technique to be discussed subsequently, which effectively determines an averaged composition throughout the surface region. Optionally, a ceramic layer overlies the surface region, to produce a thermal barrier coating system.

A method for preparing such an article comprises the steps of providing a substrate having a nickel-base alloy substrate bulk composition and a substrate surface, depositing a layer of platinum upon the substrate surface, and diffusing platinum from the layer of platinum into the substrate surface. The method further includes providing a source of aluminum and diffusing aluminum from the source of aluminum into the substrate surface for a time sufficient to produce a surface region at the substrate surface. The surface region has an integrated aluminum content of from about 18 to about 24 percent by weight and an integrated platinum content of from about 18 to about 45 percent by weight, as determined by integration, balance components of the substrate bulk composition totalling 100 weight percent. Optionally, the substrate and surface region may be annealed, and/or a ceramic layer may be deposited overlying the surface region.

Platinum-aluminide protective surface regions have been known previously, but the present approach provides an optimized platinum-aluminide coating whose elevated-temperature performance and environmental resistance are improved as compared with prior platinum-aluminide coatings. Moreover, the platinum-aluminide

coating of the invention can be utilized with advanced nickel-base superalloys without excessive coating growth during service, surface roughening, production of undesirable phases during service, or reduced stress rupture capabilities. Other features and advantages of the present invention will be apparent from the following more detailed description of the preferred embodiment, taken in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of the invention. The scope of the invention is not, however, limited to this preferred embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of a gas turbine component;

Figure 2A is a schematic sectional view through the component of Figure 1 along line 2-2, showing one embodiment of the invention;

Figure 2B is a schematic sectional view through the component of Figure 1 along line 2-2, showing a second embodiment of the invention;

Figure 3 is a block flow diagram for a method for applying a protective coating to a substrate; and

Figure 4 is a graph illustrating coating performance as a function of composition of the coating.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 depicts a component of a gas turbine engine such as a turbine blade or turbine vane, in this case depicted as a turbine blade 20. The turbine blade 20 includes an airfoil 22 against which the flow of hot exhaust gas is directed. The turbine blade 20 is mounted to a turbine disk (not shown) by a dovetail 24 which extends downwardly from the airfoil 22 and engages a slot on the turbine disk. A platform 26 extends longitudinally outwardly from the area where the airfoil 22 is joined to the dovetail 24. A number of cooling channels optionally extend through the interior of the airfoil 22, ending in openings 28 in the surface of the airfoil 22.

A flow of cooling air is directed through the cooling channels, to reduce the temperature of the airfoil 22.

The airfoil 22 of the turbine blade 20 is protected by a protective coating 30, two embodiments of which are illustrated in Figure 2A and Figure 2B. In each case, the protective coating 30 is present at a surface 31 of the turbine blade 20, which serves as a substrate 32 for the protective coating 30.

In the embodiment of Figure 2A, the protective coating 30 comprises a platinum-aluminide region 34 located at the surface 31 of the substrate 32. In the embodiment of Figure 2B, the protective coating 30 comprises a platinum-aluminide region 36 at the surface 31 of the substrate 32 and a ceramic thermal barrier layer 38 overlying the platinum-aluminide region 36. The protective coating 30 shown in Figure 2B, including the metallic region 36 (in this context termed a bond coat) and the ceramic layer 38, is sometimes termed a thermal barrier coating system. The two platinum-aluminide regions 34 and 36 may be of the same or different structures and compositions, within the scope of the invention. The platinum-aluminide regions 34 and 36 are preferably from about 0.0015 inches to about 0.004 inches thick, most preferably about 0.0025 inches thick.

Figure 3 is a block flow diagram for a preferred method of preparing the protective coatings of Figures 2A and 2B. The substrate 32 is provided, numeral 50. The substrate is a nickel-base superalloy, preferably an advanced second or third generation, nickel-base single-crystal superalloy containing substantial amounts of both aluminum and rhenium. The substrate is substantially single crystal in form, although small amounts of polycrystalline material are tolerated. The aluminum content is from about 5 to about 16 weight percent, most preferably about 6-7 weight percent, in such advanced superalloys. At least about 5 weight percent aluminum is present in order to produce a sufficiently high volume fraction of the strengthening γ' phase. The rhenium content is from about 1 to about 8 weight percent, most preferably from about 2.5 to about 6 weight percent, in such advanced superalloys. A most preferred substrate is a single-crystal substrate made of alloy RN5, having a composition, in weight percent, of 7.5 percent cobalt, 7

percent chromium, 6.2 percent aluminum, 6.5 percent tantalum, 5 percent tungsten, 1.5 percent molybdenum, 3 percent rhenium, balance nickel. Optionally, some yttrium and/or hafnium may be present. The approach of the invention is also operable with other advanced alloy substrates such as alloy RN6, having a composition, in weight percent, of 12.5 percent cobalt, 4.5 percent chromium, 6 percent aluminum, 7.5 percent tantalum, 5.8 percent tungsten, 1.1 percent molybdenum, 5.4 percent rhenium, 0.15 percent hafnium, balance nickel; and alloy R142, having a composition, in weight percent, of 12 percent cobalt, 6.8 percent chromium, 6.2 percent aluminum, 6.4 percent tantalum, 4.9 percent tungsten, 1.5 percent molybdenum, 2.8 percent rhenium, 1.5 percent hafnium, balance nickel.

The optimized platinum-aluminide coating of the invention exhibits excellent performance on a wide variety of substrate materials, but this improved performance is particularly important for these advanced single-crystal nickel-base alloy substrates. These advanced single crystal alloy substrates have higher aluminum contents than prior nickel-base superalloys, resulting in a larger amount of γ' phase, about 60-70 volume percent, than prior nickel-base superalloys. They are used at higher operating temperatures, over 2000°F, than prior nickel-base superalloy substrates, and diffusional effects are accordingly more important. The platinum-aluminide coating of the invention does not experience excessive coating growth, surface roughening, production of undesirable phases during service, or reduced stress rupture capabilities during service at such high temperatures. Accordingly, the combination of such an advanced single-crystal, nickel-base alloy substrate and the platinum-aluminide coating described next is the most preferred embodiment of the invention. The platinum-aluminide coating is not limited to use on such advanced single-crystal superalloys, however.

A layer of platinum is deposited on the surface of the substrate 32 as it then is presented, numeral 52. The layer of platinum is preferably deposited by electroplating, but other operable techniques such as sputtering and metallo-organic chemical vapor deposition may also be used. The layer of platinum is desirably about 0.0003 inches thick.

Platinum from the layer of platinum is diffused into the surface of the

substrate by heating the substrate and the deposited layer of platinum, numeral 54. The preferred diffusion treatment is 2 hours at 1800-2000°F. The steps 52 and 54 may be conducted simultaneously or serially.

A source of aluminum is provided, numeral 56, by any operable technique. Preferably, a hydrogen and a halide gas is contacted with aluminum metal or an aluminum alloy to form the corresponding aluminum halide gas. The aluminum halide gas is contacted to the previously deposited platinum layer overlying the substrate, depositing an aluminum layer over the platinum substrate. The reactions occur at elevated temperature so that aluminum atoms transferred to the surface diffuse into the surface of the platinum-enriched region and the substrate, numeral 58. The steps 56 and 58 are therefore typically conducted simultaneously.

The temperature of the treatment, the source composition, the exposure time, and the quantity of aluminum-source gas determine the amount of aluminum transferred to the substrate and diffused into the substrate. The activity of the aluminum is determined with a pure nickel foil 0.025 millimeters thick that is placed in the aluminizing reactor at the same locations where substrates are to be placed. Complications associated with the measurement of aluminum in multicomponent systems are thereby avoided. The foil is processed in the reactor so that the foil saturates with aluminum. The aluminum content of the foil is measured by acid digestion and analysis with a suitable method such as inductively coupled plasma emission spectroscopy. From these measurements, the processing of the aluminizing treatment was determined. The preferred processing produces an activity of between 40 and 50 atomic percent in a pure nickel foil. In a preferred approach, the aluminizing and diffusion treatment is accomplished at a temperature of 1925-2050°F for 4-16 hours.

After the diffusion treatment is complete, the chemical compositions of the platinum-aluminide region 34, 36 and the portion of the substrate 32 immediately adjacent to the platinum-aluminum region 34, 36 vary as a function of depth below the surface. The aluminum content and the platinum content of the platinum-aluminum region 34, 36 are relatively high adjacent to the surface 31, and decrease

with increasing depth into the region 34, 36 and the substrate 32. The remainder of the composition, totalling 100 weight percent, is formed of components of the bulk composition of the substrate alloy, which is high at a large depth below the surface 31 and decreases to a lower value immediately adjacent to the surface 31.

Because of this variation of composition with depth, the compositions of surface regions are measured by an integration method. The coated substrate is sectioned perpendicular to the surface. The weight percent of aluminum, platinum, and other elements of interest as a function of distance from the surface is determined by any technique that provides local compositions, such as an electron microprobe with a wavelength dispersive spectrometer or energy dispersive spectrometer (in conjunction with appropriate calibration standards). Measurements are taken with an electron raster that produces at least a 5 micrometer by 5 micrometer window. Such compositional measurement techniques are known in the art. Compositional measurements are taken at locations starting within 2-3 micrometers of the outer exposed surface, and increasing depth increments of 5 micrometers or less from the prior measurement. The weight percent content of the element of interest is plotted as a function of distance from the outer exposed surface, up to a maximum distance that serves as the upper limit of integration. The upper limit of the integration is selected as the distance where the weight percent of aluminum has decreased to 18 percent from the higher values closer to the surface, because below 18 percent aluminum the β-NiAl is not stable. The area under the curve is determined by any appropriate technique such as a trapezoidal approximation, and divided by the value of the upper limit of integration.

Extensive testing, to be described in greater detail subsequently, was undertaken to determine the characteristics, properties, and processing of the optimum platinum-aluminum region 34, 36. The result is that the region 34, 36 has an integrated composition of from about 18 to about 24 weight percent aluminum and from about 18 to about 45 weight percent platinum. More preferably, the integrated composition is from about 21 to about 23 weight percent aluminum and from about 30 to about 45 weight percent platinum. The balance of the composition is interdiffused components of the substrate, principally nickel, cobalt, and

chromium, so that the total of aluminum, platinum, and the diffused components composition is 100 percent.

This region 34, 36 is a single-phase, relatively ductile composition of aluminum, platinum, nickel, and the diffused components of the substrate. In the preferred approach, the region 34, 36 is about 0.0025 inches thick.

The process of Figure 3 described to this point may optionally be followed by either or both of two additional processing steps. The substrate 32 and interdiffused region 34, 36 may be annealed to stress relieve the interdiffused region 34, 36, numeral 60. This annealing procedure, while widely used for some protective coatings, has not been found necessary with the present approach. If it is used, a preferred annealing treatment is a temperature of 1800-2000°F for a time of 1/4 to 2 hours.

A ceramic layer may optionally be deposited over the surface 31 of the substrate 30, numeral 62, if the final structure is to be a thermal barrier coating system of the type depicted in Figure 2B. The ceramic layer for a thermal barrier coating 38 is preferably yttria-stabilized zirconia (YSZ) having a composition zirconia and about 6-8 percent by weight yttria, and about 0.005-0.015 inches thick. The YSZ is deposited by any operable technique, most preferably electron beam physical vapor deposition.

Coatings of a variety of platinum-aluminum region compositions were prepared by the preferred approach described above using RN5 substrates. The coated specimens were tested in burner rigs in a high-velocity 0.5 ppm salt environment at 2150°F. The lives of the coated specimens were determined in hours of exposure per mil (0.001 inch) of coating. Figure 4 depicts the results of these tests. There is a distinct region of significantly improved performance, for platinum-aluminum regions having an integrated aluminum content of from about 18 to about 24 percent by weight and an integrated platinum content of from about 18 to about 45 percent by weight, balance components of the substrate bulk composition. Particularly desirable results are obtained for an optimum compositional range wherein the integrated aluminum content of the surface region is from about 21 to about 23 percent by weight and the integrated platinum content of the surface region

is from about 30 to about 45 percent by weight. Outside of these limits, the protection afforded by the surface region decreases.

This invention has been described in connection with specific embodiments and examples. However, those skilled in the art will recognize various modifications and variations of which the present invention is capable without departing from its scope as represented by the appended claims.

CLAIMS

What is claimed is:

1. An article having a platinum-aluminide surface region, comprising:

a substrate having a nickel-base alloy substrate bulk composition and a substrate surface; and

a surface region at the substrate surface, the surface region having an integrated aluminum content of from about 18 to about 24 percent by weight and an integrated platinum content of from about 18 to about 45 percent by weight, balance components of the substrate bulk composition, totalling 100 percent by weight.

2. The article of claim 1, wherein the integrated aluminum content of the surface region is from about 21 to about 23 percent by weight and the integrated platinum content of the surface region is from about 30 to about 45 percent by weight.

3. The article of claim 1, wherein the article further includes a ceramic layer overlying the surface region.

4. The article of claim 1, wherein the thickness of the surface region is from about 0.0015 to about 0.004 inches.

5. The article of claim 1, wherein the substrate is selected from the group consisting of a turbine blade and a turbine vane.

6. The article of claim 1, wherein the nickel-base alloy substrate is substantially a single crystal and the substrate bulk composition includes from about 5 to about 16 weight percent aluminum and from about 1 to about 8 weight percent rhenium.

7. The article of claim 1, wherein the nickel-base alloy substrate is substantially a single crystal and the substrate bulk composition is selected from the group consisting of (a) 7.5 percent cobalt, 7 percent chromium, 6.2 percent aluminum, 6.5 percent tantalum, 5 percent tungsten, 1.5 percent molybdenum, 3 percent rhenium, balance nickel; (b) 12.5 percent cobalt, 4.5 percent chromium, 6 percent aluminum, 7.5 percent tantalum, 5.8 percent tungsten, 1.1 percent molybdenum, 5.4 percent rhenium, 0.15 percent hafnium, balance nickel; and (c) 12 percent cobalt, 6.8 percent chromium, 6.2 percent aluminum, 6.4 percent tantalum, 4.9 percent tungsten, 1.5 percent molybdenum, 2.8 percent rhenium, 1.5 percent hafnium, balance nickel.

8. A method for preparing an article having a platinum-aluminide surface region, comprising the steps of:

providing a substrate having a nickel-base alloy substrate bulk composition and a substrate surface;

depositing a layer of platinum upon the substrate surface;

diffusing platinum from the layer of platinum into the substrate surface;

providing a source of aluminum; and

diffusing aluminum from the source of aluminum into the substrate surface for a time sufficient to produce a surface region at the substrate surface, the surface region having an integrated aluminum content of from about 18 to about 24 percent by weight and an integrated platinum content of from about 18 to about 45 percent by weight, balance components of the substrate bulk composition.

9. The method of claim 8, including an additional step, after the step of diffusing aluminum, of

depositing a ceramic layer overlying the substrate surface.

10. The method of claim 8, including an additional step, after the step of diffusing aluminum, of

annealing the substrate and the surface region.

11. The method of claim 8, wherein the step of diffusing aluminum includes the step of

diffusing aluminum from the source of aluminum into the substrate surface for a time sufficient that the surface region has an integrated aluminum content of from about 21 to about 23 percent by weight and an integrated platinum content of from about 30 to about 45 percent by weight, balance components of the substrate bulk composition.

12. The method of claim 8, wherein the step of providing a substrate includes the step of

providing a nickel-base alloy substrate which is substantially a single crystal and has a composition that includes from about 5 to about 16 weight percent aluminum and from about 1 to about 8 weight percent rhenium.

13. The method of claim 8, wherein the step of providing a substrate includes the step of

providing a nickel-base alloy substrate which is substantially a single crystal and has a composition selected from the group consisting of (a) 7.5 percent cobalt, 7 percent chromium, 6.2 percent aluminum, 6.5 percent tantalum, 5 percent tungsten, 1.5 percent molybdenum, 3 percent rhenium, balance nickel; (b) 12.5 percent cobalt, 4.5 percent chromium, 6 percent aluminum, 7.5 percent tantalum, 5.8 percent tungsten, 1.1 percent molybdenum, 5.4 percent rhenium, 0.15 percent hafnium, balance nickel; and (c) 12 percent cobalt, 6.8 percent chromium, 6.2 percent aluminum, 6.4 percent tantalum, 4.9 percent tungsten, 1.5 percent molybdenum, 2.8 percent rhenium, 1.5 percent hafnium, balance nickel.

14. An article prepared by the method of claim 8.

15. An article prepared by the method of claim 9.

16. A method for preparing an article having a platinum-aluminide surface

region, comprising the steps of:

providing a substrate having a nickel-base alloy substrate bulk composition and a substrate surface;

depositing a layer of platinum about 0.0003 inches thick upon the substrate surface;

heating the substrate and layer of platinum to a temperature of about 1800-2000°F for a time of about 2 hours;

providing a source of aluminum in contact with the substrate surface, the source having an activity of about 40 to about 50 atomic percent as measured in a pure nickel foil; and simultaneously

heating the substrate surface and source of aluminum to a temperature of about 1925-2050°F for a time of from about 4 to about 16 hours.

17. The method of claim 16, including an additional step, after the step of heating the substrate surface and source of aluminum, of

depositing a ceramic layer overlying the substrate surface.

18. The method of claim 16, wherein the step of providing a substrate includes the step of

providing a nickel-base alloy substrate which is substantially a single crystal and has a composition that includes from about 5 to about 16 weight percent aluminum and from about 1 to about 8 weight percent rhenium.

19. An article prepared by the method of claim 16.

20. An article prepared by the method of claim 17.

NICKEL-BASE SUPERALLOY HAVING AN OPTIMIZED PLATINUM-ALUMINIDE COATING

ABSTRACT OF THE DISCLOSURE

A nickel-base superalloy substrate includes a surface region having an integrated aluminum content of from about 18 to about 24 percent by weight and an integrated platinum content of from about 18 to about 45 percent by weight, with the balance components of the substrate. The substrate is preferably a single-crystal advanced superalloy selected for use at high temperatures. The substrate may optionally have a ceramic layer deposited over the platinum-aluminide region, to produce a thermal barrier coating system. The platinum-aluminide region is produced by diffusing platinum into the substrate surface, and thereafter diffusing aluminum into the substrate surface.

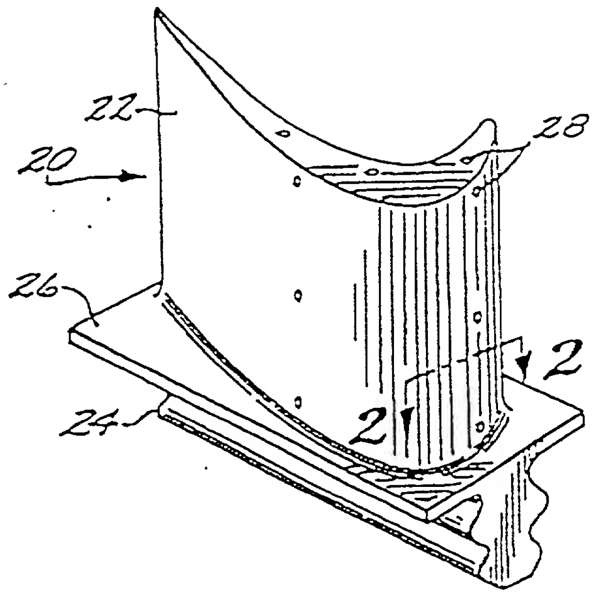


FIG. 1

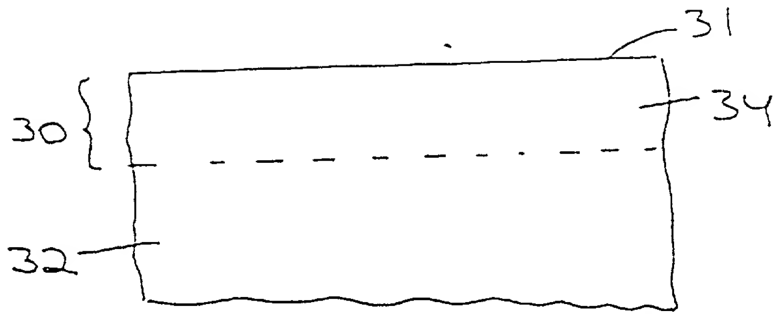


Fig 2A

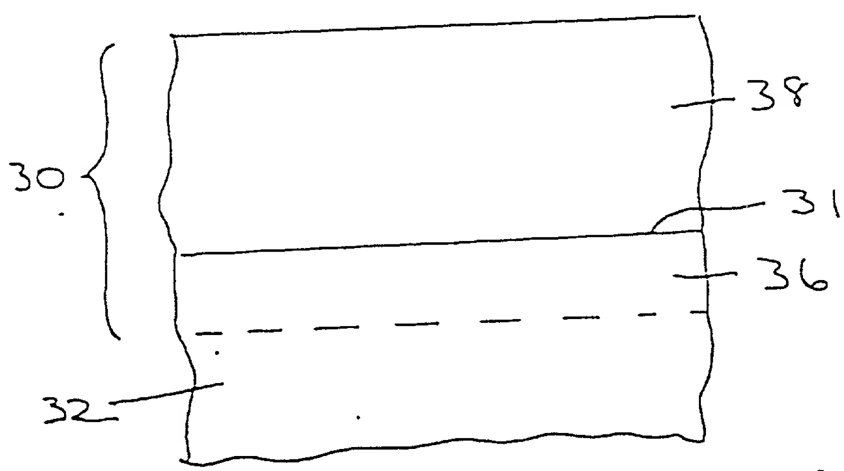


Fig 2B

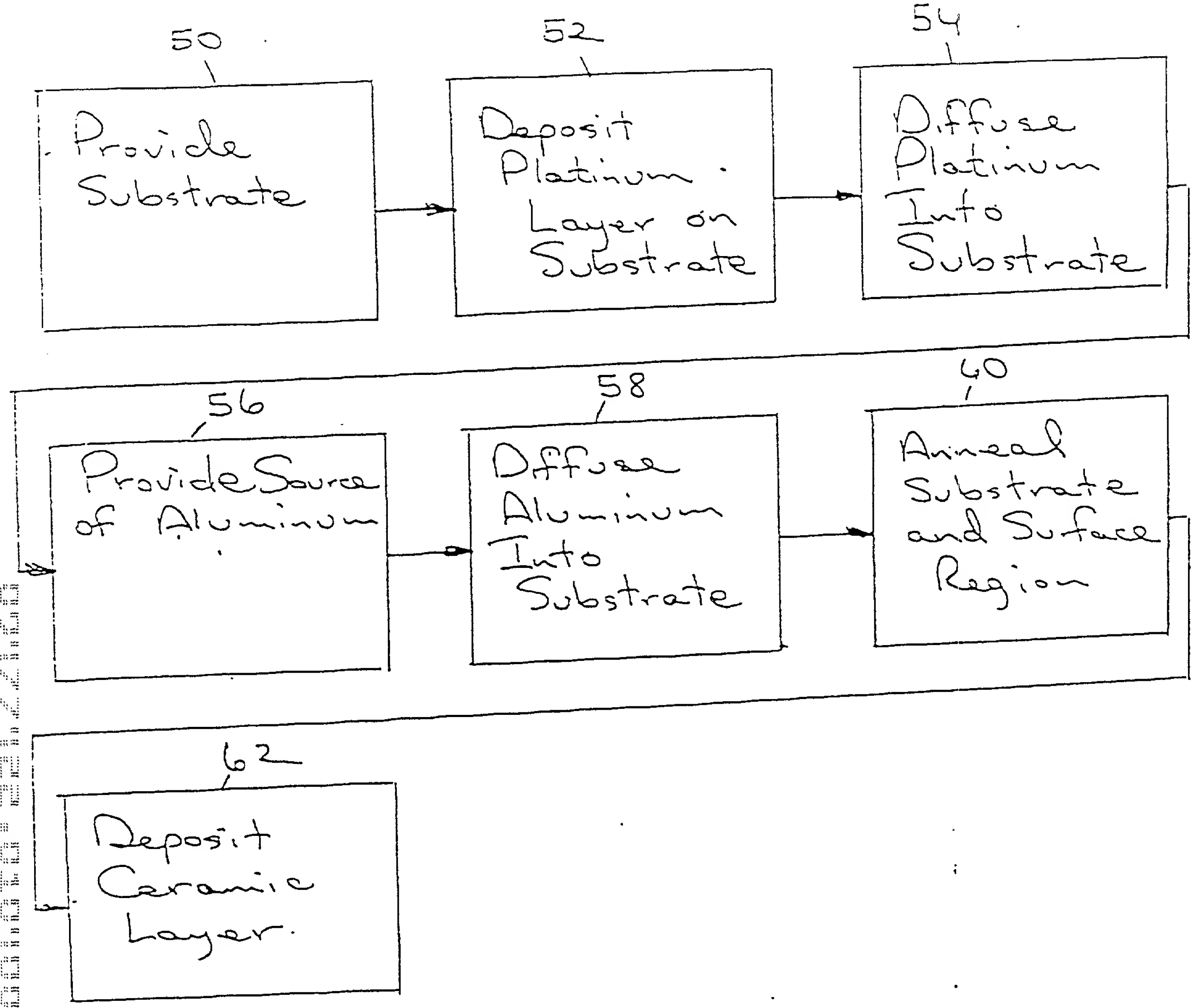
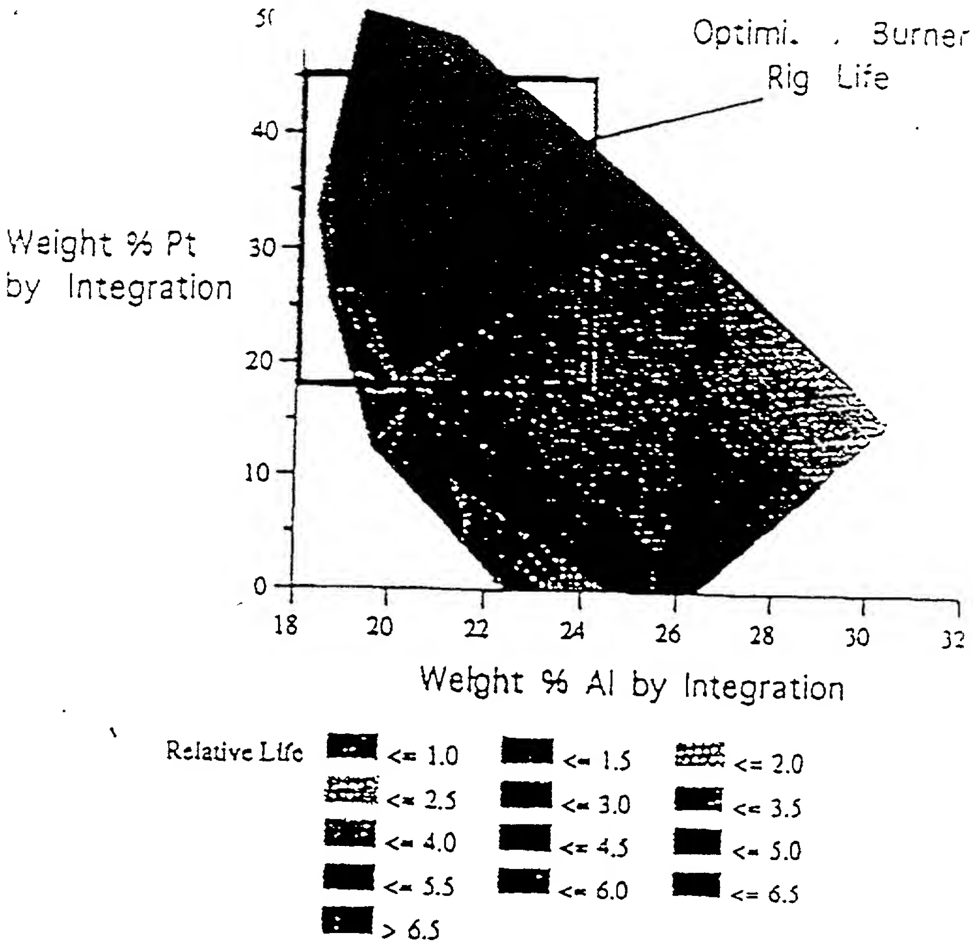

50
Provide Substrate
52
Deposit Platinum Layer on Substrate
54
Diffuse Platinum Into Substrate
56
Provide Source of Aluminum
58
Diffuse Aluminum Into Substrate
60
Anneal Substrate and Suface Region
62
Deposit Ceramic Layer.

Fig 3



Optimi. , Burner
Rig Life
Weight % Pt
by Integration
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10
20
30
40
50
18
20
22
24
26
28
30
32
Weight % Al by Integration
Relative Life
<= 1.0
<= 1.5
<= 2.0
<= 2.5
<= 3.0
<= 3.5
<= 4.0
<= 4.5
<= 5.0
<= 5.5
<= 6.0
<= 6.5
> 6.5

Fig 4

DECLARATION AND POWER OF ATTORNEY

13DV12273

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: NICKEL-BASE SUPERALLOY HAVING AN OPTIMIZED PLATINUM-ALUMINIDE COATING

the specification of which

(check one)

[X] is attached hereto

[ ] was filed on ______________ as Application Serial No. ______________ and was amended on ______________ (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information known to me which is material to patentability (as defined in 37 C.F.R. §1.56) in connection with the examination of this application. If a continuation-in-part application, I further acknowledge the duty to disclose material information which occurred between the filing date of the prior application and filing date of the continuation-in-part application which discloses and claims subject matter in addition to that disclosed in the prior application.

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose all information known to me to be material to patentability which became available between the date of the prior application and the national or PCT international filing date of this application.

Application Serial No.	Filing Date	Status (patented, pending, abandoned)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*.

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continued

DECLARATION AND POWER OF ATTORNEY

13DV12273

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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City and State

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PATENT
13DV13434

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of :
JON C. SCHAEFFER

: Group Art Unit No.:

Serial No. : Examiner:

Filed :

For Nickel-Base Superalloy Having an Optimized Platinum-Aluminide Coating :

:

ASSOCIATE POWER OF ATTORNEY

Honorable Assistant Commissioner for Patents,

The undersigned, DAVID L. NARCISO having been appointed attorney-of-record in the above-identified application hereby appoints GEORGE B. GEORGELLIS Registration No. 43,632 associate attorney with full power of delegation, substitution and revocation, to prosecute the above-identified application and to transact all business in the Patent and Trademark Office concerned therewith, and directs that all correspondence in connection with said application be addressed to:

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Respectfully submitted,

Date 1/3/00

Cincinnati, Ohio

Attorney DAVID L. NARCISO
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Telephone (513) 243-8925

PATENT
13DV13434

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of :
JON C. SCHAEFFER

: Group Art Unit No.:

Serial No. : Examiner:

Filed :

For Nickel-Base Superalloy Having an Optimized Platinum-Aluminide Coating :

:

ASSOCIATE POWER OF ATTORNEY

Honorable Assistant Commissioner for Patents,

The undersigned, DAVID L. NARCISO having been appointed attorney-of-record in the above-identified application hereby appoints STANISLAUS AKSMAN Registration No. 28,562 associate attorney with full power of delegation, substitution and revocation, to prosecute the above-identified application and to transact all business in the Patent and Trademark Office concerned therewith, and directs that all correspondence in connection with said application be addressed to:

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